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## OUR WORLD IN THE MAKING

AN example of innate conservatism, in science instead of religion, is found in the tenacity with which even scientific men are holding to a discredited hypothesis of world origin. It is now one quarter of a century since Professor T. C. Chamberlin, with the cooperation of Professor F. R. Moulton, proved that the nebular or Laplacian hypothesis for the evolution of the solar system fails at all points where it is tested by modern physical science. With the passing of the old philosophy, for the nebular cosmogonic guess was more philosophy than science, there should be abandoned the involved conception of an originally molten globe. This conception has always been a hindrance to geologic science, because most of the difficult problems in geology make the final appeal to the manner of formation, or to the initial condition, of the globe.

Instead of an initial and incandescent globe of full size the Planetesimal theory, by Professor Chamberlin, builds the earth by the slow infall and accretion of cold particles (planetesimals), with the surface of the growing globe always solid and comparatively cold. This new conception gives a better basis and more satisfactory explanation for the elusive puzzles in earth science.

This paper is not in discussion of the origin of the solar system, but it is a brief comparison of some geologic problems analyzed under the two views of the primitive earth. The cosmic process in evolution of sun and planets is a study in mechanics, physics and mathematics, and lies in the domain of astrophysics. But the formation of the globe, from its primitive condition, should be revealed in the constitution of the globe itself. The earth should have inscribed its own autobiography, and the study of such record is the province of geology. In former time the young, modest and persecuted science accepted the cosmic philosophy of Swedenborg and Kant, and the deductions by Laplace from imagined conditions, along with the involved idea of a primitive, superheated and liquid globe. The progress of geology, especially on its theoretic side, has been seriously handicapped by its deference to a mistaken geogony.

With the purpose of presenting the subject to the general reader in a single article, the facts, arguments and implications are necessarily given with brevity and incompleteness and as untechnical as possible. It is expected that experts will find occasion for criticism. Brevity is quite compulsory for the nebular column, because the conditions, surficial and internal,

of a "globe of fire" are beyond the limits of our knowledge, and we can only surmise. The increasing knowledge of matter and energy, as revealed in star and atom, may eventually give some conception of what should be the behavior of earth-stuff under enormous pressure in the interior of a molten globe.

The writings of Chamberlin and Moulton in criticism of the nebular hypothesis, and in construction of the planetesimal, are in the *Journal of Geology,* volume 5 and later volumes; the *Year Books of the Carnegie Institution of Washington,* volumes 2 to 21, 1903–1923; *Astrophysical Journal,* 1900 and later; Chamberlain and Salisbury's "Geology," volume 2; "Origin of the Earth," by T. C. Chamberlin, Chicago, 1916; Moulton's "Introductory Astronomy."

On the geologic bearings of the planetesimal theory, the evolution of the earth, consult the *Journal of Geology,* volume 21 and later; the text-books in geology by Chamberlin and Salisbury; LeConte's "Elements of Geology"; *Bulletin of the Geological Society of America,* volume 15 (1904), pages 243–266.

PROBLEMS IN GEOLOGY

| *Under the nebular hypothesis* | *Under the planetesimal theory* |
|---|---|
| **(1) INTERNAL HEAT** | |
| Is chiefly residual, or inherited from the primitive molten state. It being assumed that the high temperature of the solar nebula was partly retained until the earth-moon ring was gathered into the globe. | Is an effect of gravitational compression, with involved physical and chemical reactions, and possible radioactivity. The pressure was not exerted on matter of original high density, but on the porous accumulation of cold matter of the ingathered planetesimals. These "may have been either atoms, molecules or aggregates." |
| | It is uncertain if the present temperature of the earth as a whole is rising, falling or stationary. |
| **(2) GROWTH AND SIZE** | |
| Growth was completed, or full size attained, while the collected material was yet extremely hot, and the surface was liquid rock; over which lay an envelope of mineral vapors. | Beginning as a larger knot of the scattered solar matter the globe grew slowly by accretion of cold materials, through vast duration of time. |
| | The hypothetical stages, as conceived by Chamberlin, are described in his writings, especially in volume 2 of the "Geology." |
| **(3) SURFACE TEMPERATURE** | |
| The retained cosmic heat is assumed to have been sufficient to hold all the earth-stuff in the molten state. | The earth's surface was always solid, and comparatively cold, especially in the later stages of growth. |
| The liquid globe was surrounded by an envelope of heavy vapors, and radiation of heat was slow. | In the early stages of accretion, with possibly rapid infall, and production of some heat by the impact, the absence of an atmosphere favored rapid radiation. In later stages of growth and slower infall the larger surface of the sphere aided radiation of heat. |
| **(4) DENSITY; POROSITY** | |
| In a liquid globe no porosity appears admissible. | The ingathered planetesimals held all the substances of the earth, air and sea. With the slow accretion of cold matter, sifting down through the atmosphere in the later stages of growth, a high degree of porosity appears inevitable. Hence the surface density was always low. |
| Density was always at the maximum, for the depth. | |
| **(5) STRUCTURE** | |
| Fluidity permitted free convection, and favored homogeneity, or uniform density at equal depths. | Accretion of cold and varied materials, with probably irregular infall, produced heterogeneity of the earth's mass; with variable initial density and probably with irregularity of the surface. (See items 6 and 7.) |
| This implies the sinking of the heavier substances and the concentration of metallic alloys in the earth's central mass. This fully accounts for the high density at the earth's center. | Heating of the interior mass eventually might permit some convection and settling of the heavier substances toward the center of the sphere. This may partially account for the high density of the earth's core. |

### (6) PRIMITIVE SURFACES

On a molten globe a perfect fluid level is inevitable.

Surficial inequalities are probable in all stages of growth (items 5 and 7), because of the irregular accretion of the planetesimal matter in kind, space and time.

### (7) ORIGIN OF CONTINENTS AND OCEANIC DEPRESSIONS

One view holds that the inequalities of the earth's surface were initiated by unequal cooling and solidification of the molten surficial material; the first-called areas becoming the continents, and the later areas to solidify being the ocean "basins." (See the writings of James D. Dana and Joseph LeConte.)

Another modified view initiates the inequalities by the unequal contraction of the earth's mass, from the center outward.

These views appear inconsistent with items 4 and 5.

Water was probably held in the depressions of the earth's surface in the later stages of growth; and quite certainly when the globe was somewhat larger than the planet Mars.

With atmospheric weathering of exposed areas, and the concentration of the heavier solubles in the seas, a somewhat greater density was given the suboceanic areas. Under the principle of isostasy this difference was self-perpetuating (items 11, 12).

### (8) THE FIRST ROCKS

These were igneous and crystalline, made by the cooling and solidification of the surficial materials; these being silicates, of inferior density.

The first non-igneous deposits were the precipitates of minerals which had been held in solution in the hot ocean (see the writings of T. Sterry Hunt, in Proc. Amer. Assoc. Adv. Science, vol. 20 (1871) pages 1–59).

But no such chemical precipitates have ever been found.

Weathering and sedimentation processes became active when the globe was larger than Mars. Hence the earliest sedimentary rocks, mixtures of planetesimals, of aqueous, eolian, volcanic and possibly organic materials, are deeply buried in the earth's mass by the subsequent growth of the globe (see items 16, 17, 19, 21).

### (9) EARTH CONTRACTION; SHRINKAGE

Shrinkage of the globe, or increase in density, is attributed primarily and chiefly to loss of heat. Such contraction was mostly by crustal consolidation, the change from liquid to solid.

A possible minor factor in contraction is the reorganization of deep-seated matter under great pressure and heat.

The amount of earth shrinkage by heat radiation during geologic time is certainly negligible.

Considerable shrinkage during geologic time (item 20) is an evident fact (item 10), and no effective amount can be credited to loss of heat.

The contraction may be attributed to the condensation of the loose or porous accretionary matter, especially of the external portion of the globe (item 4); also to the expulsion of the volatile substances which have made the hydrosphere and atmosphere (items 11, 13).

Molecular reorganization of the deeply buried matter may be recognized as contributory.

### (10) CRUSTAL SHORTENING; MOUNTAIN SYSTEMS

The great existing mountain systems prove the horizontal mashing of thick rock strata during very recent time. But heat radiation during geologic time is not an efficient factor in earth shrinkage.

Increase of density by the reorganization of matter in the earth's core does not appear to be quantitatively competent.

Some elimination of occluded gaseous matter may be possible. (Item 11.) See the writings of J. D. Dana and Joseph LeConte.

All the great mountain systems of the globe have been made since the earth attained its present condition, and mostly in the latest geologic periods. It has been estimated that on any great circle of the globe the horizontal shortening, involved in mountain folding and compression faulting, must be at least one hundred miles.

The factors in later contraction noted above (item 9) may be competent to produce this contraction, which is not large when compared with the circumference of 25,000 miles.

### (11) ORIGIN OF ATMOSPHERE AND OCEAN

Most of the volume of the present atmosphere and hydrosphere must have been in the vast vaporous envelope which surrounded the incandescent globe.

Such volatile materials as were held, occluded, in the liquid rock must have

The volatile substances which had been entangled in the ingathered planetesimals were gradually forced surfaceward by the increasing pressure and heat in the growing globe (item 13). In earlier stages of the earth's growth the lighter

been mostly expelled from the crustal mass during the process of solidification, judging from the behavior of modern lavas.

Some later elimination of occluded gases, in minor amount, may be admitted. (Item 13.)

gases must have been lost into interplanetary space, because the gravitational attraction of the diminutive earth was, like the moon, incompetent to hold the flying molecules. But when the earth attained a mass somewhat larger than Mars it acquired a primitive atmosphere of the heavier gases. Eventually water vapor was retained, and its condensation produced the hydrosphere.

The air and water are the perspiration of the globe.

### (12) Volume of Atmosphere and Hydrosphere

The earth's envelopes, air and water, must have been quite at the maximum while the globe was yet hot at the surface. Minor addition in later time might be from some occluded materials in the deeper magma.

The important fact is that the earth was full size before the atmosphere and hydrosphere were created.

The great volume of water expelled from volcanoes must be regarded as meteoric (item 13).

It has been thought that the hydrosphere is now decreasing, due to absorption in the crust of the cooling globe.

Volcanoes are the vents for expulsion of the volatile materials from the earth's interior. Less conspicuous outlets are the fumaroles, solfataras and carbon-dioxide springs, like the Grotto del Cane, near Naples, Italy. It is evident that the process of expulsion is yet very active, and the earth's envelopes are in receipt of large accessions.

When the globe was small a large part of the expelled volatiles were lost, and even to-day the earth appears unable to retain gases of highest molecular velocity. Whether the supply to the air now balances the losses is not known.

It appears, therefore, that the present envelopes do not contain nearly all the volatile matter which has been forced from the earth's interior. Some accessions have possibly been obtained from interplanetary space. The hydrosphere and atmosphere are the net product of complex activities during eons of time.

### (13) Volcanism

The water of volcanoes, enormous in volume, has been regarded as meteoric, or as derived from the hydrosphere. It is assumed that the water finds its way down to the volcanic reservoir even against the pressure and heat which produces the violent expulsion.

The alternative view is to suppose that much of the present air and water was held, in occlusion, in the molten magmas; for volcanism has been active during all geologic time. But the conception of a primitive molten globe has not been favorable to the idea of an immense volume of occluded magmatic gases. However, the basins on the moon, some of great size, have been attributed to intense volcanism.

Volcanic gases of the various kinds, water the most abundant, are magmatic. They were part and parcel of the cosmic stuff of which the earth was built. They are forced surfaceward by the pressure and heat of the interior.

Volcanism was probably most active during the stages of growth preceding the geologic record of the sedimentary rocks. (The theoretic stages are given by Professor Chamberlin in volume 2 of the "Geology." The lunar craters resemble craters of impact, like Meteor Crater in Arizona (see papers by D. M. Barringer; also Bull., Geol. Soc. Amer., vol. 18, pages 493–504).

If lunar craters are the effect of impacts, and due to the infall of massive planetesimals, it gives interesting suggestion as to the character of some of the earth-moon stuff.

### (14) Genesis of Vein Minerals

The postulate of a molten globe has not favored the existence of great volume of interior, or magmatic, volatiles. Hence the ascending heated vapors and liquids responsible for many mineral deposits have been credited to

Mineral deposits associated with eruptive phenomena are mostly attributed to superheated vapors and fluids. Quartz veins carrying metals are clear examples of the work of ascending superheated water. Such process

previously descended meteoric waters.

implies large volume of magmatic volatiles in the earth, below the reach of meteoric waters.

### (15) SURFACE, OR EPIGENE, AGENCIES

Geologic processes on the earth's surface, as seen in action to-day (rain, river, wind, frost, etc.), could not have come into effect until the earth and its hot ocean had cooled down to a temperature comparable to the present. Hence epigene processes are definitely limited to the latest phase of the earth's history.

When the atmosphere and the primitive seas came into existence, with the globe larger than Mars, the surficial geologic processes began. All the epigene activities, including the chemical, and possibly the biologic processes, were in operation while the juvenile earth was growing by the abundant infall of planetesimal matter (items 16, 18, 21).

### (16) BURIED SEDIMENTARY ROCKS

All the rocks produced by epigene processes, the stratified and sedimentary, must be superficial; and should be mostly visible and unaltered. Immediately beneath the observable base of the sedimentaries there should be found either the primitive igneous rocks of the cooling crust, or the precipitates from the hot ocean (item 8).

Stratified or sedimentary rocks, comparable to the sands and clays of to-day, were deeply buried in the earth during the later stages of the growing globe. And with these deposits were mingled the infalling planetesimal matter, and probably organic substances (items 17, 19, 21).

Under the conditions of heat and pressure produced by the subsequent burial of those early sediments they have been altered (metamorphosed) into what we call igneous rocks.

### (17) SOURCE OF ATMOSPHERIC CARBON-DIOXIDE[1]

Under the former view, involved with the nebular hypothesis, all the $CO_2$ was originally held in the primitive atmosphere.

Under any modified view of later supply to the air, from volcanic sources, it must yet be admitted that the initial atmosphere should have been too rich in $CO_2$ to permit of the conditions of climate and of life which certainly existed far back in Precambrian time (items 18, 21).

Like all the volcanic gases the $CO_2$ is magmatic, and has been continuously supplied from the earth's interior since some very early stage of the growing globe.

Ever since the hydrosphere existed a withdrawal of $CO_2$ from the air has been in action, by the storage in the rocks, ocean and organisms. It may not be supposed that these two opposing processes were always balanced. Perhaps decided unbalancing initiated climatic changes (item 18).

The present content of the atmosphere is the net result of complex physical, chemical and biologic processes since the earth was about the size of Mars.

### (18) ANCIENT CLIMATES

Because of excess of $CO_2$ and of water in the atmosphere of early geologic time the ancient climates should have been hot, humid and suffocating for all animal life.

The slow withdrawal of the $CO_2$, by storage in the earth, has slowly produced our present sky conditions. Hence world climate has slowly and steadily changed from hot to cold. And the Glacial Period is a premonition of the final refrigeration.

It is now certain that glaciation has often occurred in the past, even far back in Precambrian time (see "Ice Ages, Recent and Ancient," by A. P. Coleman, New York, 1926). This was long before the storage of vast amount of carbon in the limestones and coals of the Paleozoic era. And there have been later epochs of cold and aridity, particularly in the Permian Period. Such conditions demand thin and transparent atmosphere.

The fossils of the Cambrian indicate that

[1] To-day the $CO_2$ constitutes one part in three thousand of the atmosphere. But the ocean is the storehouse of the gas, holding, it is estimated, eighteen times as much as the air. The oceanic content was probably derived from the air by carbonation of the crystalline rocks. Certainly all the carbon now stored in peat and coal, in limestones and marble, and in living plants and animals, has been withdrawn from the atmosphere. The amount of carbon tied up in the carbonaceous deposits and the calcareous rocks has been estimated as twenty thousand to thirty thousand times the present atmospheric content.

the sky conditions in that ancient time were comparable to the present. And the entire geologic record, in rocks and fossils, shows that world climates have always been similar to the present.

### (19) ORIGIN OF HYDROCARBONS

Because the interior or magma of an originally molten globe could not retain large quantity of volatile substances it is necessary to attribute petroleum and rock gas to some surficial source or process. Hence the hydrocarbons have been wholly credited to organic origin. It may be admitted that the substance of plants and animals originally held in limestones and shales have been in some cases expelled and reservoired in porous sandrocks.

While the above explanation may be conceded for many of the oil and gas fields, it is not entirely satisfactory for some localized reservoirs of great volume; nor for the peculiar relations in the "salt domes" of the Gulf coastal plain; nor for the association of the hydrocarbons with crystalline rocks and volcanic phenomena.

All the elements of rock-oil and rock-gas, as well as those of all plants and animals, were originally in the cosmic matter, the planetesimals, and were buried in the growing globe. In time they were partially expelled, along with other volatiles, and eventually the C, H, O and N became the substance of organisms.

These elements are yet being extruded from the earth, and against the magmatic origin of the hydrocarbons there is only a negative chemical argument.

But granting the exclusive organic genesis of the compounds there is yet a valid compromise explanation. If life existed on the earth when the globe was much smaller than to-day (item 21), and it certainly existed in pregeologic time, then organic matter became deeply buried in the ancient deposits.

There may be three immediate sources of the hydrocarbons: (1) from organic material in recent strata; (2) from organic material in deeply buried pregeologic deposits; and (3) from the original planetesimal materials.

The hydrocarbons associated with volcanism may be from either (2) or (3).

### (20) LENGTH OF GEOLOGIC TIME[2]

Geologic time, or the reign of formative epigene processes, comparable to those at present, is strictly limited to the time since the globe cooled to a surface temperature somewhat like the present tropics.

Estimates of such duration by physicists and astronomers range from ten to one hundred million years. Geologists and paleontologists have not found this long enough to produce the succession of rock-strata and the evolution of life.

Epigene processes probably were effective when the globe was somewhat larger than Mars. Hence Precambrian time was of vast duration, covering not only eons while the earth was gathering its mass, but also the great length of time since growth was completed, but preceding the Cambrian, or the clear stratigraphic record.

Geologists estimate time since the Cambrian as at least one hundred million years, and since epigene agencies and life began as perhaps one thousand million years. It is only a guess. But under the planetesimal theory the student of earth science can reasonably claim all the time he needs.

### (21) LIFE ON THE EARTH

Origin of life on the earth is limited to the time since the globe cooled to a condition similar to the present time.

Precambrian time, as allowed under the hot-globe idea, appears too

Physical conditions requisite for at least low forms of life probably were fulfilled when the globe was two thousand miles less than its present diameter. This permits vast length of time for the slow evolvement

[2] The term "geologic" is meant to cover only the latter part of the earth's history, or that which is revealed in the observable rock strata. The story is definite and clear for only the unaltered sedimentary rocks, beginning with the Cambrian. Many Precambrian rocks, although much changed (metamorphosed) by pressure, heat, flowage, etc., at great depths, yet indicate formative conditions, by the epigene agencies, not radically unlike the rock formations of recent time.

short to allow the evolution of the Cambrian fauna.

found in the Cambrian of low organisms up to the complex animals strata. That development was at least half of the evolution process from the amoeba to man.

The origin of life is not within the scope of this writing.

### COMMENT

In the above comparison, which is intended to be fair and impartial, the reader will find only one item in which the nebular view might be held superior in its explanation of the earth's features and structure. That is number five, concerning the excessive density of the earth's core. Most of the topics, especially after number eight, are decidedly unfavorable to the nebular view.

HERMAN L. FAIRCHILD
UNIVERSITY OF ROCHESTER

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## ON THE SIGNIFICANCE OF SCIENCE[1]

*Honored Members of the Twelfth Congress on Physiology,*

*Ladies and Gentlemen:*

THE chancellor of the Swedish universities has been prevented by indisposition from being their spokesman on this memorable occasion. Charged with the duties of the chancellor I have been bound to enter into his place. Certainly all of us regret, as much as Dr. Swartz, that he can not realize to-day his keen desire to speak here. We wish him rapid progress in his convalescence. In accordance with his request I transfer to all of you, ladies and gentlemen, his sincere greetings.

Thus it is my most agreeable privilege to express on behalf of the Swedish universities and Swedish research our common joy and pride in receiving in our country so many renowned investigators of the human organism and its functions. To our hearty welcome we add the wish and the hope that your stay in our capital may be fruitful for your high scientific task and pleasant and recreative for each and every one of you.

It was said during and after the world war that if science appeared in the Council of Nations it ought to adorn itself with a bloody vestment, since it served and multiplied destruction everywhere. In large groups of our generation a dire lesson has changed idolatry of science into depreciation of it.

Is science then morally indifferent, so that it can serve death as well as life, the devil as well as God? The problem is not as simple as one might think. In any case there is a moral element in all genuine research. For it belongs to the nobility and sanctity of science to be faithful to its own inmost self. Science must be treated as master, not as servant. It can not without detriment to its purity and success be made ancillary to ready-made dogmatics or wishes. "Naturae non imperatur nisi parendo." It follows its own law. Therefore it requires of the investigator not only labor and perseverance, acuteness of mind and essential imagination, but it requires also self-discipline, subordination of the own ego to higher aims, and conscientiousness and a sincere striving to discover the real connection and character of things and organisms. Therefore, research gives in normal cases to men a stamp of earnestness and truth. A closer investigation will show that deficiency in the moral character must sooner or later have an unfavorable effect on research and its results, at least in important and delicate tasks.

The primitive peoples practice what they call white and black magic, that is sorcery which is used in furtherance of life and sorcery which is used with evil intent. They are right in condemning the latter kind of the primitive science and technic, which we call magic. In the same way modern science must not be used for unworthy purposes. It is a degradation of research to be made subservient to private and collective egoism, to the detriment of mankind.

When science is underrated, one forgets its rôle of furthering life and humanity. During the world catastrophe science exhibited, if possible, still more self-sacrificing zeal and still more genius than ever before, in helping charity to heal and cure, to soothe and comfort. You, gentlemen, are benefactors of humanity, because you represent with honor the art of healing. That redoubles the joy we feel that your international scientific gathering has chosen to meet in the capital of Sweden.

If we consider the relation between science and practical purposes we find a seeming contradiction.

The aim of medical research is practical: to help and strengthen life. Also outside medicine an investigator can be inspired by a conscious practical goal, and that increases his humanity if the goal is good. But the remarkable thing is that the usefulness of science to human life and civilization is not accomplished through any practical aim. It belongs to the secret of science that it serves the practical needs of life best in working with a purely theoretical view. The desire to know carries research out into unknown

[1] Welcome to the Twelfth International Congress of Physiology meeting at Upsala by the pro-chancellor of the University of Upsala and the Archbishop of Upsala.

tracts, its advances led only by its method. Here a contradiction appears, which is apt to give occasion to reflection and which lets us perhaps surmise or even perceive a greater personal and spiritual connection, which is not accessible to science as such. I mean that seeming contradiction, that research proves to be most practical when it is purely theoretical. Science has made many of its greatest conquests when, impelled by its own genius, it has said, not: I want to accomplish, I want to rule, but only I want to know. Saul, the son of Kish, went out in his daily business and sought after his father's asses, but he found a royal crown. In the same way science does not always know where it will arrive. But advancing with unswerving faithfulness to its own principles and with an unselfish, exalted desire to widen the limits of knowledge, advancing in severe self-discipline and self-forgetfulness it attains to ends exceeding abundantly all that it could hope or think.

It belongs to the proud charter of science to be itself and to obey its own law. But when science is faithful to itself and works without by-designs, it gains a still greater glory than knowledge and its own inviolate independence. It proves to be a servant of life. No quality of research is more wonderful. When a discovery has been made through the sole unprejudiced desire to know, it appears that life and humanity profit by it in a way that is most unexpected—perhaps epoch-making.

Therefore I greet you as knights of science and as servants of life, and I wish you continued success in your high calling.

NATHAN YODERBLOM

THE UNIVERSITY OF
UPSALA

## SCIENTIFIC EVENTS

### WIRELESS RESEARCH IN ENGLAND

ACCORDING to an article in the London *Times* the wireless division of the National Physical Laboratory at Teddington continues to make good progress with the several and varied problems which are submitted to it for solution by the Radio Research Board. For several years past a comprehensive investigation has been carried out on the mode of propagation of wireless waves over the earth's surface, and for this purpose apparatus has been developed for the accurate simultaneous measurement of both the intensity and direction of arriving wireless waves. This work has recently led to some most successful demonstrations of the existence of an upper ionized layer at the top of the earth's atmosphere, which serves to deflect wireless waves reaching it and to return them to the earth's surface. By taking account of the combination of these downcoming waves with those transmitted straight along the earth's surface, an explanation can be given of all the phenomena of fading of wireless signals and the erratic behavior of wireless direction finders when the transmission is over any but the shortest distances. In a similar manner the influence of the atmosphere can be shown to account for the wonderful results which have been obtained by both amateur and professional workers in transmitting over very long distances with short waves. In this connection it may be noted that a small frame aerial receiving sets with only two valves has been used at the laboratory for the reception of signals on short wave-lengths from a small ship's transmitter at a distance of over 7,000 miles. These investigations are being continued as a means of obtaining further knowledge about the parts of the upper atmosphere which are beyond the reach of the direct observations employed in meteorology.

Another portion of the wireless work of the laboratory concerns the complete study of the behavior of valve amplifiers for use in receivers used for broadcasting and general purposes. For this purpose a somewhat elaborate equipment has been built up, using the most modern measuring apparatus, for testing the effective magnification given by valve amplifiers as well as the amount of distortion which they may introduce when used for the reproduction of speech and music. A feature of this equipment, to which the staff of the laboratory have devoted a great deal of attention, is the manner in which portions of the apparatus are shielded by metal plates and wire gauze from the effects of stray electric and magnetic fields, which would seriously detract from the accuracy of the measurements. In one case a whole room has been completely lined with galvanized iron wire netting of small mesh to protect the apparatus within from these stray effects.

In addition to research on wireless receivers a certain amount of work is carried out in connection with wireless transmitters. The major portion of such work is confined to the use of special forms of transmission to meet the needs of other investigations. Also, by the aid of its standard wave meter for the measurement of wave-length or frequency, the laboratory continues to maintain a regular program of the transmission of standard waves of accurately adjusted length or frequency, by means of which any listener within range may calibrate a wave meter or receiver.

In order to keep pace with the rapid development which is taking place in the science and practice of wireless communication, the staff of the National Physical Laboratory has found it necessary to acquire a detailed knowledge of the technique applying to a very large range of wave-lengths. On account of the

very specialized nature of the work, much of the apparatus is designed and constructed at the laboratory, although full cognizance is taken of the progress of design and manufacture which is continually taking place in the wireless industry. As the various researches are completed the results are published in the form of official reports, papers read before scientific societies, or articles in the technical press, and they are found to be of great value to all those engaged in the wireless profession, as well as to those who have found wireless an interesting hobby.

## EXPEDITION TO CENTRAL AMERICA FOR MEDICAL RESEARCH

MEMBERS of the research expedition to the tropics of Central America, organized by the Johns Hopkins School of Hygiene and Public Health and conducted under the auspices of the International Health Board of the Rockefeller Foundation, returned on September 15.

Dr. W. W. Cort, professor of helminthology at the Johns Hopkins University, was director of the expedition. Others on the staff were Dr. Maurice C. Hall, chief of the zoological division of the U. S. Bureau of Animal Industry; Drs. N. R. Stoll and Harold Brown, of the Johns Hopkins University; D. L. Augustine, of the Harvard Medical School; W. A. Riley, of the University of Minnesota, and W. C. Sweet, of the Rockefeller Foundation. Besides gathering much information on parasites and parasitic diseases, the expedition brought back about 150 bottles of prevailing parasites, some of them apparently new and of economic and scientific importance.

Dr. Hall made the following statement regarding the results of the expedition:

> The trip has furnished a valuable background of tropical conditions as regards factors in parasitic development. In the extent and nature of diseases of livestock caused by parasites in the countries visited, the findings were unexpected and reassuring in many respects. The range cattle of those countries proved to be practically free from gastro-intestinal parasites, and in many cases appeared to be entirely so. While there is an abundance of moisture and warmth in the tropics, things which themselves are favorable to parasites, the seasonal distribution of rain is highly unfavorable to parasite eggs and larvae.
>
> In the countries visited—Panama, Nicaragua, Salvador and Guatemala—there are from two to six months, as a rule, and more in exceptional seasons such as this year, when there is no rain whatever. In the absence of moisture the hot tropical sun has a desiccating effect which is fatal to parasite eggs and larvae and no doubt has a decided sterilizing action on bacteria. Furthermore, the rains themselves are torrential and in the mountainous countries must have a washing effect which serves to sweep worm eggs and larvae into the many water courses and out of contact with livestock. There is little overstocking on these ranges and consequently there is a lack of concentrated infection.

One important object of the expedition was to determine what tropical diseases are likely to be carried northward by shipments of livestock. The survey has given a satisfactory answer to that question.

Cattle in the countries visited suffer from ticks and tick fever. Tuberculosis appears to be rare among the range cattle; the bacterial diseases of importance were anthrax, blackleg and tetanus. In contrast to the relative freedom of range livestock from parasites, household animals in the countries visited showed fairly extensive infestation. Swine especially suffer from kidney worms which cause considerable loss of meat and lard. Another common swine parasite causes the disease known as swine measles or cysticercosis, due to bladder worms in the meat. These bladder worms are the larval stages of a large and dangerous human tapeworm.

The results of the expedition show that in shipping livestock from Central America to the United States the only diseases of livestock that appear to warrant serious consideration are tick fever, anthrax, blackleg and tetanus, though final conclusions depend on the identification of the parasites collected and also on further studies in Central America. Dr. Hall made his examinations of animal parasites largely at local abattoirs, in collaboration with Dr. Augustine.

## SELECTION OF A CHEMIST FOR THE UNITED STATES BUREAU OF CHEMISTRY

THE United States Civil Service Commission states that the position of chemist in charge of drug control investigations in the Bureau of Chemistry of the Department of Agriculture is vacant, and that, in view of the importance of the position in the field of pharmaceutical and pharmacological research, and to insure the appointment of a thoroughly qualified man for the work, an unusual method of competition will be followed to fill the vacancy. Instead of the usual form of civil service examination, the qualifications of candidates will be passed upon by a special board of examiners, composed of Dr. W. W. Skinner, assistant chief of the Bureau of Chemistry, Department of Agriculture; Dr. G. W. McCoy, director of the Hygienic Laboratory; Dr. H. A. B. Dunning, of Hynson, Westcott and Dunning, Baltimore, Maryland; Dr. Carson P. Frailey, secretary of the American Drug Manufacturing Association, and Dr. A. S. Ernest, examiner of the United States Civil Service Commission, who will act as chairman of the committee. For the purposes of this examination all

these men will be examiners of the Civil Service Commission.

The examination will consist solely of the consideration of qualifications by this special board. The minimum qualifications for consideration are a Ph.D. degree from a college or university of recognized standing or an M.D. degree from a medical college of recognized standing; and, in addition, at least six years of experience involving the direction or performance of important research work along pharmaceutical or pharmacological lines; familiarity with medical, chemical and pharmaceutical activities and the literature bearing upon such subjects; contact work with scientific and professional organizations and associations concerned with this character of work.

The duties of the position are to be in responsible charge and to direct the work of the following bureau activities:

(1) The Office of Medical Review, consisting of medical experts whose duty it is to consider therapeutic claims made on medicinal preparations to determine whether these claims are justified by the composition of the article and are in compliance with the provisions of the Food and Drug Act.

(2) Analytical Control Laboratory, which acts as a standardization unit for all analytical drug work of the field laboratories.

(3) Research Unit, which studies the composition of active constituents of drug products and devises new analytical methods in collaboration with the state, academic and trade laboratories.

(4) The Pharmacognosy Laboratory, engaged in the identification and classification of crude drugs and in studies of their potency.

(5) A general supervisory relationship between the incumbent and the bio-assay and other pharmacological work on drugs carried on by the pharmacological laboratory.

The entrance salary for this position is $5,200 a year. Promotion may be made without change in assignment up to $6,000 a year.

Qualified persons who wish to be considered for this vacancy should apply to the United States Civil Service Commission, Washington, D. C., for Form 2118 which must be executed and returned, with a list of the applicant's technical publications and reprints of such of these publications as are available, to the office of the Civil Service Commission at Washington not later than November 9, 1926.

## THE FIFTIETH ANNIVERSARY OF THE JOHNS HOPKINS UNIVERSITY

THE JOHNS HOPKINS UNIVERSITY will celebrate its fiftieth anniversary with a two-day program of scientific and scholarly exercises on October 22 and 23, which it is expected will be attended by more than 2,000 alumni from all parts of the world and a number of distinguished visitors from foreign universities.

The main events of the celebration will be: Scientific addresses by representatives of English, French and German universities; exercises commemorating the founding of the university in 1876; dedication of the new $1,000,000 building of the School of Hygiene and Public Health, and conferences in sixteen branches of science and scholarship.

Dr. Andrew Balfour, director of the London School of Hygiene and Tropical Medicine, is making a special trip from England to make the main address at the dedication of the school on October 22. He will speak on "Hygiene as a World Force," emphasizing the important part being played by preventive medicine in the progress of modern civilization.

L. Levy-Bruhl, professor of the history of modern philosophy at the Sorbonne, Paris, will be the principal speaker at the exercises on October 22, commemorating the foundation of the philosophical faculty. "Research as it is To-day" will be his topic.

Germany will be represented at the celebration by Professor F. Neufeld, director of the Berlin Institute for Infectious Diseases. He will deliver two addresses under the DeLamar Lectureship Foundation, and will deal with problems in immunity and the control of infectious diseases.

The sixteen departmental conferences in the main branches of learning will be conducted along lines similar to those of the meetings of national scientific societies. Among the alumni who will speak at these conferences on scientific subjects are:

Henry Van P. Wilson, professor of biology, University of North Carolina.

Ross G. Harrison, professor of anatomy, Yale University.

W. C. Coker, professor of botany, University of North Carolina.

Joseph Jastrow, professor of psychology, University of Wisconsin.

Edward C. Franklin, professor of organic chemistry, Stanford University.

William H. Burnham, professor of pedagogy, Clark University.

William S. Bayley, professor of geology, University of Illinois.

Florence Bascom, professor of geology, Bryn Mawr (first woman to be granted the degree of Ph.D. at Johns Hopkins).

George Otis Smith, director of the U. S. Geological Survey.

Benjamin Leroy Miller, professor of geology, Lehigh University.

D. W. Ohern, formerly professor of geology in the University of Oklahoma.

Marcus I. Goldman, of the U. S. Geological Survey.

Luther P. Eisenhart, professor of mathematics, Princeton University.

Arthur B. Coble, professor of mathematics, University of Illinois.

Henry B. Brooks, chief of the electrical instrument and meter section of the U. S. Bureau of Standards.

## THE INTERNATIONAL TUBERCULOSIS CONGRESS

FOR the first time since 1908 the International Union Against Tuberculosis has convened in America. The sessions took place in Washington from September 29 to October 2, with Dr. Theobald Smith, director of the department of animal pathology of the Rockefeller Institute for Medical Research of Princeton, as president.

Fifty-eight foreign medical men, from twenty-two countries, were in attendance, and more than 500 physicians and public health workers from the United States gathered to attend the sessions. The program was followed by the twenty-second annual meeting of the National Tuberculosis Association, October 4 to 7.

Among the members from foreign countries in attendance were:

Austria—Professor Dr. Ernst Loewenstein, Vienna.

Canada—Dr. Jabez H. Elliott, Toronto; Professor Arthur Rousseau, Quebec; Professor James Miller, Kingston.

Czechoslovakia—Dr. Vladimir Novak, Brno.

England—Dr. F. J. H. Coutts, London; Sir Henry Gauvain, Alton; Miss Olga Nethersole, London; Dr. Nathan Raw, Richmond, Surrey; Dr. P. C. Varrier-Jones, Cambridge.

Scotland—Dr. Fergus Hewat, Edinburgh.

Wales—Colonel S. Lyle Cummins, Cardiff.

France—Dr. Leon Bernard, Paris; Mlle. Helene Mugnier, Lyons; Dr. B. Weill-Halle, Paris; Dr. Edouard Rist, Paris; Dr. F. Humbert.

Germany—Professor Friedrich von Müller, Munich; Dr. Friedrich Neufeld, Berlin; Frau Professor Lydia Rabinowitsch-Wempner, Berlin; Dr. Ferdinand Sauerbruch, Munich; Professor Dr. Hugo Selter, Bonn.

Holland—Dr. P. J. L. DeBloeme, Amsterdam.

Italy—Professor Vittorio Ascoli, Rome; Dr. G. B. Roatta, Florence; Professor Gaetano Ronzoni, Milan.

Japan—Dr. Rokuro Takano, Tokio.

Norway—Professor Francis Harbitz, Oslo.

Portugal—Professor Thiago d' Almeida, Porto.

Sweden—Professor Hans Christian Jacobaeus, Stockholm.

Switzerland—Dr. Frederick Jessen, Davos Platz; Dr. Jaquerod Leysin; Dr. Ernest Zueblin, Zurich.

Venezuela—Dr. Carlos J. Bello, Caracas.

There are four counselors of the International Union from the United States: Dr. James Alexander Miller, president of the New York Tuberculosis and Health Association, New York City; Dr. Theobald Smith, president of the International Union Against Tuberculosis and the National Tuberculosis Association; Dr. Gerald B. Webb, Colorado Springs, Colo., and Mr. Linsly R. Williams, managing director of the National Tuberculosis Association.

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## SCIENTIFIC NOTES AND NEWS

IN 1927 the American Philosophical Society will celebrate the two hundredth anniversary of its founding. It has been decided to combine this celebration with the annual general meeting of the society, the dates fixed being April 27, 28, 29 and 30, 1927. The following resolution has been passed by the society: "That preparations be made to invest the annual meeting of the society in 1927 with a dignity and public importance worthy of so notable an anniversary in the world's history of learning."

THE American Association for the Advancement of Science has been invited to take charge of one of the meetings held in connection with the Sesquicentennial International Exposition. The meeting will be held in the Educational Building at three o'clock on the afternoon of October 16, the general subject being "The Contributions of Science and its Applications to the Welfare of the Nation since the Signing of the Declaration of Independence." Dr. John M. Coulter, professor emeritus of botany in the University of Chicago, past president of the American Association, will preside and open the discussion. Addresses will be made by Dr. C. E. McClung, professor of zoology and director of the laboratories at the University of Pennsylvania; Dr. J. McKeen Cattell, editor of SCIENCE, formerly professor of psychology at the University of Pennsylvania and Columbia University; Dr. W. A. Noyes, recently professor of chemistry and director of the laboratories at the University of Illinois, and Professor Dexter S. Kimball, professor of industrial engineering and dean of the College of Engineering of Cornell University.

THE Sweet Memorial Professorship Fund established at Cornell University in memory of Professor John Edson Sweet, the distinguished mechanical engineer who died in 1916, has now received subscriptions amounting to $119,000.

THE Terry lectures for 1926–27, by Professor Robert A. Millikan, of the California Institute of Technology, were given at Yale University on October 13, 14 and 15. They will be repeated in Bridgeport at the United Congregational Church on October 17, 18 and 19.

DR. RICHARD WHIDDINGTON, Cavendish professor of physics and dean of the faculty of science at the University of Leeds, gave a lecture on the Bartol Research Foundation at the Franklin Institute on October 13. The subject of Dr. Whiddington's address was "The Luminous Discharge through Rare Gases."

PROFESSOR F. NEUFELD, director of the Robert Koch Institute of Infectious Diseases, Berlin, who gives two lectures under the DeLamar Lecture Foundation at the Johns Hopkins University on October 22 and 23, will deliver the first Harvey Society lecture at the New York Academy of Medicine on Saturday evening, October 30. His subject will be "Recent Investigations in Tuberculosis."

DR. S. G. BARKER, head of the physics department of the British Research Association for the woollen and worsted industries, has been appointed director of research in succession to Mr. H. J. W. Bliss, who has resigned.

DR. GEORGE T. MOORE, director of the Missouri Botanical Garden, has been elected to membership in the executive committee of the Institute for Research in Tropical America.

THE faculty of the Detroit College of Medicine and Surgery will give a dinner on October 19 in honor of Dr. Angus McLean, emeritus professor of surgery.

DR. VICTOR HAYES was installed as president of the Cincinnati Academy of Medicine on September 28.

PROFESSOR C. E. TURNER, of the department of biology and public health of the Massachusetts Institute of Technology, has been called upon to create a curriculum of health education in the public schools of Cleveland, Ohio.

DR. ALBERT G. NICHOLLS, for about twelve years professor of pathology and bacteriology at Dalhousie University, pathologist to the Province of Nova Scotia and director of provincial public health laboratories, recently resigned these positions.

DR. JAN SCHILT, formerly of the Leiden Observatory, has been appointed research assistant at the Yale Observatory.

HAROLD S. PALMER, professor of geology at the University of Hawaii, has been granted a sabbatical leave from the university for research in Europe and the South Seas.

PROFESSOR WILLIAM J. HUSSEY, of the University of Michigan, accompanied by Mrs. Hussey and Professor and Mrs. Richard A. Rossiter, left New York on October 9 on a year's expedition to South Africa, there to map the double stars of the Southern Hemisphere. A 27-inch telescope has already been shipped.

EDW. M. EHRHORN, for the last seventeen years chief of the division of plant inspection of the Board of Agriculture and Forestry, Honolulu, Hawaii, has retired from active service and is now engaged as consulting entomologist for several corporations in the work of termite control.

DR. P. A. ROSS, assistant professor of physics in Stanford University, and Dr. Warren W. Nicholas, who took his doctor's degree in physics at Stanford last June, will work at Cornell University with Professor F. K. Richtmyer the coming academic year in research in X-rays.

NELS A. BENGTSON, professor of geography at the University of Nebraska, is now a fellow at Clark University, where he is carrying on graduate work in geography.

DR. FREDERICK S. HAMMETT, of the Wistar Institute of Anatomy and Biology, addressed the Brooklyn Academy of Arts and Sciences on October 2 on "The Thyroid and the Reproductive System."

PROFESSOR FRIEDRICH VON MULLER, of the University of Munich, has given four Mayo Foundation lectures at Rochester. The subjects of his lectures to the fellows and faculty of the foundation were "Complications following Encephalitis," "Disturbances of the Bones and Joints caused by Aberrant Metabolism," "Granular Kidney" and "Goiter."

DR. EDOUARD RIST, of Paris, and Sir Henry Gauvain, of Alton, England, have arrived in Rochester, Minn., to give Mayo Foundation lectures. Both came to this country to attend the International Tuberculosis Congress and the meeting of the National Tuberculosis Association.

DR. ERNST COHEN will give a public lecture on "Van't Hoff, his Life and Work," at Brown University on October 11. The lecture is under the joint auspices of the John Howard Appleton Fund and the Rhode Island section of the American Chemical Society.

DR. FRANCIS HARBITZ, director of the institute of pathology at the University of Oslo, Norway, delivered the annual Gross Lecture of the Philadelphia Pathological Society at the College of Physicians, on October 11, on "Periarteritis Nodosa."

COLONEL E. LYLE CUMMINS, David Davies professor of tuberculosis, Welsh National School of Medicine, will deliver the Hermann M. Biggs Memorial Tuberculosis Lecture on October 22, at the New York Academy of Medicine, on "Clinical Differences in the Course of Tuberculosis seen in Various Age Groups and Races."

BEFORE the British Chemical Society on October 28,

the lecture founded in memory of the late Dr. Hugo Müller will be delivered by Professor S. P. L. Sörensen, of Copenhagen, who has chosen as his subject: "The Composition and the Characterization of Proteins."

IN the Royal Botanic Garden at Edinburgh on September 21, a tablet was unveiled to the memory of the late Sir Isaac Bayley Balfour, who was Regius keeper of the Garden from 1888 until 1922.

DR. FRANCIS E. NIPHER, professor emeritus of physics at Washington University, died on October 6, aged seventy-eight years.

DR. ALDO CHARLES MASSAGLIA, formerly professor of pathology and bacteriology at the University of North Dakota School of Medicine, died on September 2, aged fifty years.

DR. F. ALEXANDER GUTBIER, professor of chemistry at the University of Jena, committed suicide on October 5 in his laboratory by shooting. Professor Gutbier was fifty years old.

DR. E. KROMPECHER, professor of pathologic anatomy at the University of Budapest, has committed suicide on account of ill health by throwing himself from a window.

THE annual meeting of the American Ornithologists' Union was held at the Victoria Memorial Union, Ottawa, Canada, from October 11 to 14. An exhibition of ornithological art was a feature of the meeting.

THE genetics sections of the American Society of Zoologists and the Botanical Society of America will hold their annual meetings in Philadelphia on December 27, 28 and 29, in connection with the meetings of the parent societies. Titles and abstracts of papers to be presented should reach the section secretary not later than November 15. Persons who are not members of either parent society may present papers by introduction. Papers may be presented by (a) formal reading (limited to fifteen minutes), (b) informal demonstration, or (c) title only. All titles, however they are to be presented, should be accompanied by a typewritten abstract of not more than 250 words. Further information may be obtained from Dr. L. C. Dunn, secretary, Storrs Agricultural Experiment Station, Storrs, Connecticut.

THE Association of State Foresters, with members of the United States Forest Service attending as invited guests, held its annual meeting in Baltimore from October 11 to 13. In conjunction with the Baltimore sessions, trips were taken out into Maryland to see what this state is doing in fire prevention and suppression, forestry work with private owners, planting of young forest trees, and general educational work in forestry. After their sessions and trips in Maryland, the foresters will come to Washington for conferences from October 14 to 15 with officials of the United States Forest service on the cooperative work under the Clarke-McNary Act—prevention and suppression of fire, forest taxation, distribution of planting stock to farmers, aid in handling woodlots, etc.

ACCORDING to a press dispatch, the Japanese government is planning to turn over the buildings of the Imperial Parliament for the meetings of the Pan-Pacific Scientific Congress, which is to assemble in Tokio on October 29 for a two weeks' meeting.

THE opening of the new home of the New York Academy of Medicine has been postponed until November. Meetings will be held in the present building on Forty-third Street until the new building is dedicated.

BEQUESTS by the late Mrs. Kate S. Richardson, of New York, include the sum of $100,000 to the Peabody Museum of Salem.

IT is announced that Colonel William Boyce Thompson plans to convert a tract of 300 acres he owns on a ridge near Grassy Sprain Reservoir in Yonkers into an arboretum which will be opened to the public. The arboretum will be a part of the Boyce Thompson Institute for Plant Research.

A GROVE of redwoods on the Redwood Highway 250 miles from San Francisco has been deeded to the State by Mrs. Kate Felton Neilson in memory of her father, Charles N. Felton, one time United States Senator from California. This addition to the holdings of the State is said to be one of the most beautiful stands of virgin redwood trees in the vicinity of the Dyerville-Bull Creek area and contains approximately 100 acres with more than 7,000,000 feet of redwood timber. Since its organization in 1918 the Save-the-Redwoods League has preserved through appropriation and gift more than 3,000 acres of primeval redwoods representing a valuation of close to $1,000,000.

AFTER conferences at the State House, Boston, on October 4, in which reports upon the investigation of the alleged cattle fraud were laid before Governor Fuller, the governor sent for Dr. Lester H. Howard, director of the Division of Animal Industry, and asked him to resign from the position. Dr. Howard's department has been charged with negligence as the result of the cattle frauds, recently brought to light. The method by which the state has been mulcted was that after a cow had been tagged as tubercular, and

the state payment for the animal made after it was ordered shot, the tag was removed and the cow transferred to another, who proceeded to again collect damages from the state.

THE Royal Veterinary and Agricultural College of Denmark, from August 24 to 27, celebrated the completion of an extensive building program which has greatly increased its research and educational facilities. The dedication ceremonies were attended by the King, members of the cabinet, foreign diplomats and scientists representing the following countries: United States, Great Britain, France, Germany, Belgium, Sweden, Norway, Iceland, Finland, Poland, Switzerland, Holland, Austria, Czechoslovakia, Hungary, Italy and Spain. The director of the college, Professor H. O. G. Ellinger, delivered the principal address using seven different languages. Technical addresses were delivered by Professor Hutyra (Hungary), Dr. Tage U. H. Ellinger (United States), Professor P. Guinier (France), Professor Marchlewski (Poland), Professor H. Perrin (France) and several members of the Danish faculty.

THE *Official Record* of the United States Department of Agriculture states that representatives of ten of the leading forestry schools of the country gathered at the Forest Products Laboratory of the Forest Service at Madison, Wis., during the week of August 30 for the second annual Forest School Conference. The purpose of the conference is to harmonize research on forest products as carried on by the Forest Service at the Madison laboratory and by the various schools of forestry and to promote the exchange of information between these agencies. The time of the recent conference was given to detailed presentations and discussions of "Utilization Methods employed by Industry to Use and Prevent Wood Waste."

*Industrial and Engineering Chemistry* summarizes information contained in a recent publication of the United States Civil Service Commission entitled "Opportunities for Chemists in the U. S. Civil Service" as follows: It confirms the fact that the government is a notoriously poor employer so far as rates are concerned. There are 805 chemists noted in this publication. A classification by income shows the following: five at $6,000–7,500; thirty-four at $5,200–6,000; one at $4,500; one at $4,200; twenty-seven at $3,800–5,200; seventy-five at $3,800–5,000; two at $3,800; six at $3,300–3,900; five at $3,200–3,400; one at $3,000–3,900; one hundred and eighty-five at $3,000–3,600; three at $2,700–3,000; two hundred and thirty-two at $2,400–3,000; one at $2,400–2,700; four at $2,100–2,700; five at $2,100–2,500; three at $2,000–2,250; one hundred and sixty-six at $1,800–2,400; forty-nine at day rates in navy. A classification by specialists shows that of the 805 there are 314 analysts, 45 inorganic chemists, 96 physical chemists, 206 organic chemists, 94 under more than one classification and 50 devoting themselves to executive work.

THE United States Department of the Interior announced recently that educational work in the National Parks of the West is being carried on this year on a larger scale than ever. The Field School of Natural History which was inaugurated in Yosemite National Park last year, has been continued during 1926. Three times as many persons have sought enrollment this year as in 1925. Two years of college work or the equivalent is necessary for enrollment. The work of the field school supplements the lower division university courses in botany and zoology, bringing first-hand acquaintance with various living forms. As the school is a contribution to nature education by the National Park Service, assisted by the California Fish and Game Commission, no tuition is charged. Lecture room, library and other facilities are available in the new museum building.

A SYSTEMATIC biological survey of Mt. Desert Island and the surrounding waters is being carried forward under the leadership of Mr. Wm. Procter, of Bar Harbor, Maine. The survey will deal first with the marine fauna in determining what and where the various forms may be found and in obtaining information regarding their breeding habits. The results will, if approved, be published at once and in accumulative form from year to year as the work progresses, so that such information as is acquired may be immediately available to investigators who wish to work at Mt. Desert. A corps of competent zoologists was organized for the work during 1926, headed by Dr. Henry C. Tracy, of the University of Kansas. When the survey is completed in part it will be presented to the Mt. Desert Island Biological Laboratory for publication and for the use of the workers at this laboratory.

## UNIVERSITY AND EDUCATIONAL NOTES

ON the occasion of the opening lecture of Dr. Fritz Paneth as visiting professor at Cornell University, it was announced that the anonymous donor of the $250,000 given last year to the university for non-resident lectureships in chemistry is Mr. George F. Baker, of New York, financier and philanthropist.

THE Studebaker Corporation, of South Bend, Ind., has given to Harvard University the sum of $10,000 a year for two years as a fund for research into the best methods of regulating street traffic. Dr. Miller McClintock is in charge of the work.

RUTGERS UNIVERSITY has established a department of plant pathology at the College of Agriculture and appointed Dr. William H. Martin, professor of plant

pathology, as head of the department. It was also voted to establish a department of water supplies and sewage disposal, with Dr. Willem Rudolfs in charge.

PROFESSOR F. H. ALBEE has resigned the chair of orthopedic surgery at the University of Vermont. The position has been filled by the appointment of Dr. B. H. Whitbeck, of New York City.

DR. PHILIP H. MITCHELL has been promoted from an associate to a full professorship of physiology at Brown University. He has been a member of the Brown faculty since 1907.

W. B. JEWELL, Ph.D. (Princeton, '26), has been appointed assistant professor of geology at Vanderbilt University.

AT the Utah Agricultural College, Dr. W. W. Henderson has been appointed professor of entomology and Dr. F. B. Wann associate professor of botany.

APPOINTMENTS in the college of mines and engineering of the University of Arizona have been made as follows: Professor James C. Clark, of the Westinghouse Electric Company, will be acting professor of electrical engineering during the absence of Dr. Paul Clarke; E. J. Borquist, of the University of Utah, will take the place of Professor Frank Garron, who has accepted a position in the faculty of the University of North Carolina, in the civil engineering department; Dr. R. J. Leonard, formerly of the University of Minnesota and the Oregon Agricultural College, will take the chair of geology and mineralogy left vacant by Professor Vincent L. Ayres.

DR. PEDRO N. ORTIZ has been appointed professor of tropical diseases at the Columbia School of Tropical Medicine, at San Juan, Porto Rico.

## DISCUSSION

### THE METRIC MOVEMENT

IN the House of Representatives, May 13, 1926, Mr. Britten introduced a joint resolution, relating to the establishment of commodity quantity units for general use in merchandising after 1935. The resolution is brief, consisting of about six lines, namely:

> That the United States Department of Commerce is authorized to establish commodity quantity units for general use in merchandising after 1935, standardizing the yard to the meter, the quart to the liter, the pound to five hundred grams, decimally divided.

Mr. Britten, it may be recalled, introduced H. R. Bill 10, extending the use of metric weights and measures in merchandising which gave the manufacturer and business man ten years to accommodate himself to conditions arising from the adoption of a metric system of weights and measures. Mr. Britten has made a long and praiseworthy fight to provide legislation lifting business methods out of the quagmire of antiquated, unscientific and inappropriate units.

It may be of interest to run over briefly the arguments advanced by those who are opposed to the introduction of metric units, as shown in the Hearings before the House Committee on Coinage, Weights and Measures, 69th Congress. In the main, these objections rest on anticipated expense, confusion and litigation.

A prime purpose of those who favor the use of the metric system is of course to eliminate confusion; but the opponents of the system persist in claiming that great confusion will result.

A typical line of argument is that of the American Railway Engineering Association. In the opinion of certain engineers it would cost the railroads of this country:

| | |
|---|---|
| For changing mile posts | $ 1,835,000 |
| For changing tariffs | 100,000,000 |
| For changing standard plans | 15,000,000 |
| For changing shop machinery, tools, etc. | 216,000,000 |
| Add also maintenance of property | 60,000,000 |
| And 6 per cent. on additional investment | 19,970,000 |
| Grand total over | 400,000,000 |

Comment is hardly needed. Wear and tear of brain by engineers and others might have been included and listed at several million dollars. Nor has it occurred to these gentlemen that there might be some offset as the years rolled on due to the use of simplified accounts, time-saving units and scientific methods.

Opposed to this bugbear of expense, largely imaginative, may be set the experience of the Baldwin Locomotive Works filling an order on drawings made in metric units.

> The engines went through the shops without any extra cost or expense over and above what they would have cost built on the English system and with fewer mistakes than they would have expected to occur in the English system.

It may be recalled, too, that the bugbear of expense was held out as an objection to the introduction of proper heating apparatus in railway cars. Ditto automatic couplers. Ditto almost every improvement looking to safety of the travelling public. And yet no railroad man to-day would wish to return to coal stoves, old-fashioned brakes and couplers.

The attitude of the manufacturer is perhaps best shown by the testimony of the representative of the American Telephone and Telegraph Company. His concluding words are:

> You talk to a scientific man and he will say "I am in favor of the metric system. I think it is good." Now

what does he mean; he is a scientist, he does not worry about the cost of production. But when you talk to the man who has got to make money enough to keep him engaged producing goods and make a profit on his investment, he commences to get out a paper and figure out what it means.

But what if the man who *pays* is not the manufacturer; but the dear public? And while there may be manufacturers who keep scientific men employed for the mere pleasure of so doing, in general the ultimate gain goes not to the scientific worker but to the employer.

Perhaps the most amusing logic was that of the representative of the Retail Dry Goods Association. We quote:

> Some time ago a foreigner went into a store and said "I want to buy a collar." He expressed it in the metric system. The clerk said "We have not got it in that system, we have it in the English system. Can you tell me what it is in the English system?" He said "No, I can not tell you what it is in the English system." The clerk said, "I will tell you what to do, take off your collar and I will measure it." The man said, "I can not do that, it is attached to my shirt."

What happened after that we are not told. Evidently an impasse. Possibly there was no sale! Possibly the manager considered the expenditure of a tremendous sum to make up collars in metric units. And possibly some budding genius in real salesmanship got out of his pocket a piece of string, measured the neckband and then found the required size. And the mirage of tremendous expense faded pleasantly out of the scene.

One great mystery remains. "How did the hypothetical purchaser of collars expect to attach a second collar to a shirt already provided with one?" A second mystery is, "Why did the representative of the Retail Dry Goods Association offer this illustration as a valid argument against the use of metric units?"

Meanwhile engineers are quite generally decimalizing the inch. And across the big pond, the British are abolishing pole, furlong, league, grain, dram, stone, quarter, peck, bushel, chaldron, barrel, square rod, perch, rod and, last but not least, the hundredweight of 112 pounds. Our transatlantic slow-movers seem to be a lap ahead of us.

ALEXANDER MCADIE

BLUE HILL OBSERVATORY

## INSTITUTIONAL SOURCES OF INDUSTRIAL RESEARCH MEN

IN a previous communication[1] we discussed our early experience in finding researchful young scientists. We think that every laboratory director will agree with the observation made therein that it should be his ambition to attract, rather than to seek, qualified scientific investigators. It is not so generally appreciated, however, that a knowledge of the domestic history of the important research training-schools not only facilitates the prognosis of the investigational possibilities of candidates therefrom, but also renders less difficult any necessary quests for research men possessing specific qualifications.

Researchful young men are most easily located in or through the universities, and therefore the laboratory director will find it advantageous to establish and maintain occasional contact as well as cordial relations of cooperation with the heads of the scientific departments of the larger educational institutions. This favorable connection between industry and education is one of the benefits that come from the regular attendance of both pure and applied scientists at conventions of professional societies and also at the meetings of the American Association for the Advancement of Science. We have been aided constantly and invaluably in getting chemists and other scientific specialists by our friendly relations of reciprocity with college and graduate-school teachers.

The list that follows presents the names of the institutions that have each supplied five or more incumbents of industrial fellowships of Mellon Institute during the past fifteen years (1912 to the present

INSTITUTIONS REPRESENTED IN LARGEST NUMBER IN MELLON INSTITUTE, 1912–1926

| Names of Institutions | Degrees B.S. and A.B. | M.S. and M.A. | Ph.D. and Sc.D. |
|---|---|---|---|
| Allegheny College | 5 | 1 | |
| Carnegie Institute of Technology | 8 | 1 | |
| Chicago, University of | 4 | 4 | 16 |
| Clark University | 4 | 3 | 1 |
| Columbia University | 7 | 7 | 2 |
| Cornell University | 7 | 2 | 4 |
| Harvard University | 2 | 2 | 4 |
| Illinois, University of | 15 | 10 | 7 |
| Iowa State College | 2 | 4 | 3 |
| Johns Hopkins University | 3 | | 8 |
| Kansas, University of | 27 | 10 | 2 |
| Nebraska, University of | 3 | 5 | |
| New Hampshire College | 9 | 3 | |
| Ohio State University | 17 | 14 | 9 |
| Pennsylvania State College | 9 | | |
| Pittsburgh, University of | 34 | 36 | 31 |
| Southwestern University | 5 | | |
| Wisconsin, University of | 6 | 6 | 2 |
| Yale University | 5 | 3 | 10 |
| Other institutions (102) | 137 | 40 | 20 |

[1] Hamor, SCIENCE, n.s., *51* (1920), 625–7.

day). We hope it will be of suggestive help to the many research directors who have asked us, "Where do you find your Industrial Fellows?"

W. A. HAMOR
MELLON INSTITUTE OF INDUSTRIAL RESEARCH,
UNIVERSITY OF PITTSBURGH

## ZOOLOGICAL NOMENCLATURE

THE secretary of the International Commission on Zoological Nomenclature has the honor to invite attention of the zoological profession to the fact that application has been made for the suspension of the international rules, in the case of Hübner's (1806) "Tentamen" in order to establish its nomenclatorial availability.

Briefly summarized: The formal nomenclatorial status of this document, involving about one hundred names admitted by some authors as of generic rank, has been under controversy for many years, and opinion of specialists in *Lepidoptera* is still divided.

The arguments, as submitted, in favor of suspension of rules, maintain that: (1) there are sound reasons both for admitting and for denying recognition to the "Tentamen," from the standpoint of interpreting the rules; (2) the evidence *pro* and *con* is not sufficiently conclusive to remove the question from debate; (3) the rejection of the "Tentamen" will produce greater confusion than uniformity, will necessitate a vast amount of undesirable labor and economic loss of time and work; (4) if, on the ground of expediency, the rules can be suspended in this case, the nomenclature of the *Lepidoptera,* as used for the past thirty years, can be largely maintained.

The "Tentamen" is one of the most important and most controversial cases ever submitted to the commission. A discussion, with essential bibliographic references, will be found in "Smithsonian Misc. Coll., v. 73 (4)" (now in press).

The commission will delay announcement of vote, on the requested suspension, at least until September 1, 1927, in order to give interested authors, and especially entomological societies, opportunity to study the premises and to present to the commission their views and arguments, *pro* or *con,* regarding the action requested.

In order to protect groups other than *Lepidoptera,* a prerequisite to suspension of rules would be that representative specialists in *Lepidoptera* agree upon and furnish to the commission definite bibliographic references to the 107 names which they view as genotypes.

C. W. STILES,
*Secretary to Commission*
U. S. HYGIENIC LABORATORY,
WASHINGTON, D. C.

## THE ENDOWMENT OF AN INDIVIDUAL

A CORRESPONDENT asks us to print the following communication:

Here is a man with most extensive education, training and experience, chronologically seventy years of age, but physiologically about fifty-five years old, according to his Johns Hopkins medical friends. He graduated (A.B.) from college and then studied law for one year (his father was a lawyer and desired his son to follow him); but did not like it; then he pursued theology three years and graduated, but was not satisfied; then went to Harvard and took ten courses in philosophy for two years and then wrote a thesis on "Certainty" and concluded there was none, except the *feeling* of certainty. On this thesis he was given a fellowship in psychology at Johns Hopkins; still he was not contented.

As he had lived in German and French families to prepare himself for European study, he went there (Universities of Berlin, Leipzig, Paris, Zurich and Vienna) to study medicine mainly, also psychophysics and anthropology under leading specialists. He had no intention of practicing medicine, but simply studied it, taking a full course as a foundation for the scientific study of modern civilized man.

As he spoke the languages fluently, the professors invited him to their homes to learn all about America. He in turn learned much of their inward thoughts. After this ten years of postgraduate study he applied scientific methods to the investigation of the criminal, pauper and defective classes; then to the insane, seeking the *causes* of their failure to make good citizens.

But it is more important to know why people are successful rather than why they are failures. So lately he has applied scientific methods of investigation to the upper or successful classes of citizens. The methods of study are exactly the same, both for the normal and abnormal, otherwise they could not be compared.

But with all this training this man has been crippled almost to the zero point by poverty, though his equipment cost him twenty thousand dollars or more, most of which he earned by tutoring or through scholarships received from universities. He has written numerous works and articles recognized as much (if not more) in other countries as in the United States. He has been a pioneer and followed his highest instincts (costly), and as a consequence has been forced to live on an annual salary of $1,500 under our government.

Perhaps there is no man in this country or Europe

with a broader and more thorough training under the very best specialists that the world could afford. He is equipped to do synthetic work that no other or very few could do in the scientific study of modern man as he is now. While he had a full and better medical course in medicine than most physicians have ever enjoyed, he was also trained well in experimental psychology and also in anthropology, and he is now applying anthropology and psychology to medicine. Thirty years ago he started the word "Social-Pathology," which has come to be adopted in the English language. He is now starting new research under the title of anthropological psychiatry, and more lately new studies of Congress under the head of legislative anthropology. Such a man should be utilized.

## THE A. CRESSY MORRISON PRIZE

EARLY this year The New York Academy of Sciences offered two prizes of $250 each known as the A. Cressy Morrison Prizes for 1926, one of which is to be awarded (in December of this year) for the best essay on intraatomic energy of the sun. It has been called to our attention that in the issue of SCIENCE dated August 13 of this year there is a paragraph stating this fact but quoting the subject erroneously as "*inter*-atomic energy of the sun." As there is of course a great difference between *inter*-atomic and *intra*-atomic energy and as this paragraph has already caused considerable query and surprise among astronomers I am wondering if you would not be good enough to correct this statement in an early issue of SCIENCE as the papers must be presented to the secretary of the academy prior to November 1.

ROY WALDO MINER,
*Recording Secretary*

## SCIENTIFIC BOOKS

*The Families of Flowering Plants, I. Dicotyledons, Arranged According to a New System Based on Their Probable Phylogeny.* By J. HUTCHISON. xi–328 pp., 264 figs., numerous maps. Macmillan & Co., London, 1926.

IT may be said unreservedly at the beginning that this book is of the greatest interest and importance for all botanists whose activities extend beyond the naming of plants and the arranging of them in herbaria, and it is of especial importance to students of fossil plants, who are presumably interested in phylogeny.

The book returns in a measure to the ideas of Bentham and Hooker in their classical Genera Plantarum, but departs from them in many commendable respects. Briefly, it contains a discussion of the principles of classification, with some comments upon previous attempts, an annotated list of the families, an artificial key to the families, a well-illustrated account of the orders and families, a glossary and a good index.

The author considers that the dicotyledons fall naturally into two series: one, mostly arborescent, starting with the Magnoliales; and a second, mostly herbaceous, starting with the Ranales (restricted). These two lines evolve independently, except that the Urticales, Umbellales and Asterales are derived through both, *i.e.*, they are polyphyletic.

The outstanding difference from the system of Engler and Prantl (so-called), with which it is natural to compare the present attempt, is in regarding all the so-called Apetalae as reduced forms. Some probably are, others are not, and I would dissent from the author's conclusions on account of the geological record, and for the familiar reasons, too lengthy to enumerate here, but which have been stated many times during the discussions of the last fifty years. The "universally accepted theory of the foliar origin of the carpel" may be no more fundamental than the distinction of monocotyledonous and dicotyledonous seedlings, which is a bugbear that is likely to persist for years to come. Certainly there is no fossil evidence that entomophily preceded anemophily, and fossils with the latter habit are rather more conspicuous in Mid-Cretaceous floras than are the former.

It is impossible, with our present knowledge, to demonstrate phylogenetic hypotheses, and it is doubtless illusory to attempt to do so. At the same time, it seems to me highly desirable that those who know plants should give their colleagues the benefit of their conclusions, however these may fall short of demonstration. Only by friendly discussions and further investigations can we progress toward the goal.

It should be understood, therefore, that the following comments, both commendatory and adverse, represent my personal opinions, and do not detract in any way from my admiration of Hutchison's book or my belief in its usefulness, since, after all, the bulk of the text consists of a well-illustrated and admirably characterized account of all the families of dicotyledons, which is entirely objective.

In working out his scheme the author seems to me to lose sight of the fact that the familiar trends from single to aggregate fruits, polycarpy to oligocarpy, monoecious to dioecious, hypogeny to perigyny or epigyny, etc., are present in all sorts of combinations in unrelated families, and are of the nature of parallel adaptations, seemingly reversible even within the limits of a single family.

Despite the promise of the foreword, contributed by A. W. Hill, I can not discern that the author has

taken the very considerable fossil record into account beyond being influenced by the entirely speculative essay of Arber and Parkin. Floral morphology, perhaps the most variable feature in plants, is greatly overweighted in this as in all classificatory schemes, and I fancy that I can see the ghosts of Bentham and Hooker influencing some of the author's decisions.

It seems to me that more consideration should be given to the evidence of the probable late origin of such herbaceous groups as the Cruciferae and Caryophyllaceae. For example, in seeking to justify his separation of woody and herbaceous plants Hutchison says, "Many of the primitive families are either entirely woody or entirely herbaceous" (page x), and then names under the second category the Ranunculaceae, Papaveraceae, Crassulaceae, Saxifragaceae, Caryophyllaceae and Cruciferae. That any of these are primitive is almost entirely a matter of opinion. Surely the Crassulaceae are rather specialized, all are practically unrepresented in the fossil record, and there are many facts that suggest their relative modernity. It should be recognized that extreme habitat specializations, *e.g.*, to shores and salt pans (Frankeniaceae, Plumbaginaceae) or to aridity (Cactaceae, some Euphorbiaceae) do not give issue to new types, but represent blind endings which are likely to be comparatively modern, as is further indicated by their restricted distribution.

From a fair knowledge of both distribution and geology I venture to think that the so-called Wegener hypothesis of continental displacement raises many more problems than it solves.

I am heartily in sympathy with Hutchison's sharpening and multiplying the orders. The old aggregations that passed as Ranales and Geraniales have been sadly in need of segregation for a long time, and I am glad to see the Laurales set apart and the shifting of the Piperales from a primitive to a derivative position. I much doubt the suggested alliance between the ancient (despite the aforementioned ghosts) Proteaceae and the Thymeleaceae, the separation of the Hydrangeaceae and Saxifragaceae, or of the Myrsinaceae and Primulaceae, although I concede that the last may have a foundation.

Hutchison considers the Juglandales as derived rather late from the Sapindales, although the former appear early in the geological record, as do also the Moraceae; and the Fagales are among the earliest clearly recognized angiosperms.

The Platanaceae, although antedating both in the rocks, is considered to have been derived from the Rosales through the Hamamelidales, and to lead to the Amentiferae. The question of direction of evolution is a puzzling one in all groups of organisms, but I believe that the direction has been reversed in this instance.

There is a vast amount of inertia among systematists, whether it be in the writing of regional floras, or the arrangement of herbaria, and it is doubtful and probably not desirable that Hutchison's scheme should be adopted. A pious wish for international uniformity in taxonomy is probably as elusive a will-o-wisp as international comity, or the nomenclatural stability that we have heard so much about during the last thirty years, but that the first general phylogenetic presentation of dicotyledons after nearly forty years of systematic activity should not receive the attention and discussion which it deserves is unthinkable.

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## SCIENTIFIC APPARATUS AND LABORATORY METHODS

### THE CULTIVATION OF OPALINA

IN a recent paper appearing in SCIENCE,[1] a report was made on the reaction of Opalinas to various laboratory media. The maximum period over which these animals could be made to live was seventy-three hours. In working upon a problem of the specificity of Opalinas in frogs, we found that this period was too short for the purposes of our experiments.

A search of the literature on this subject revealed a method used by Konsuloff[2] in 1922 which succeeded in maintaining Opalinas in culture for two months. There was one fault to be found with this method, however; he had to change the medium every day. For our purposes this was unsatisfactory. Therefore we refined Konsuloff's technic until we have succeeded in cultivating Opalinas for twenty-five days without having to change the medium.

The procedure is as follows. Pütter's fluid, which has the following composition, is used.

| | | |
|---|---|---|
| NaCl | .8 per cent. sol. | 100 parts |
| Rochelle salts | 30.0 per cent. sol. | 5 parts |
| Distilled water | | 400 parts |

This is made with boiling distilled water to ensure as complete sterility as possible. After this has cooled it is subjected to the action of a suction which is maintained until bubbling ceases. This removes any excess air, a factor which has been demonstrated by Konsuloff to be lethal if permitted to remain. To this fluid is added, in the proportion of .25 grams to 200

[1] Larson, Van Epps, and Brooks, SCIENCE, Vol. LXII, No. 1604, page 289, (1925).

[2] Konsuloff, S., "Untersuchungen über Opalina," *Archiv. f. Protistenkunde*, Band 44, Heft 3, (1922).

cc fluid, powdered egg white. This is added just slowly enough so that no flocculation occurs. The fluid is then put in 15 cc centrifuge tubes to the amount of 9 cc per tube. The Opalinas are introduced by a capillary pipette after having been removed from the cloaca of the infected frog and having been washed once in either Ringer's or Pütter's fluid, without the egg white. This last procedure tends to reduce the amount of extraneous matter. About .1 cc of fluid containing a heavy concentration of Opalinas is introduced into each tube. These tubes are then corked with one-hole rubber stoppers. As a final seal, the holes of the stoppers are closed with small glass plugs. This arrangement permits the escape of the air that would otherwise be confined under pressure in the tubes. The presence of this pressure was found by Konsuloff to kill the cultures. All the glassware and corks were sterile before using.

In order to observe the animals without removing them from the tubes and thereby introducing air and bacteria which would lessen the length of the period of cultivation, a binocular microscope was set up horizontally and the tubes held singly at the correct focal distance.

We hope that this technic in the cultivation of Opalinas will be of some help to others working in this field.

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## A SIMPLE METHOD OF OBTAINING SINGLE-SPORE CULTURES

WHILE working with species of Fusarium the writer developed a method of obtaining single-spore cultures that seems simpler and more rapid in operation than methods previously described. A piece of soft glass tubing is heated over a Bunsen flame and drawn out to an inside diameter slightly greater than that of the spores to be isolated. Care in the amount of heat to be applied and a little practice in manipulation is necessary to obtain suitable diameters. The prepared capillaries are broken up into lengths of about three cm and filled by means of capillary attraction from a spore suspension made in warm nutrient agar. After a few trials a spore dilution is easily made that will give from one to four spores to the tube.

The filled tubes are then examined under the microscope and broken up according to the number and position of the spores observed. The resultant pieces are again examined to make sure that each contains one spore only, then picked up with forceps, immersed in alcohol to sterilize the outside and placed in the desired medium. By using a solid rather than a liquid medium the filled tubes may be broken without disturbing the contents and sterilized without injury to the spores.

Should it be desirable to obtain cultures from a single hypha, then the piece of glass tube with the spore is pushed to the bottom of the medium in a Petri dish where germination may be followed under the microscope; as soon as the germination hypha has grown beyond the end of the tube it is cut off and the glass removed. A single hypha is very easily obtained in this manner because of the macroscopic size of the glass tube.

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# SPECIAL ARTICLES

## DIET AND BODY FAT

IN a study[1,2] of the influence of diet upon the quality of fat produced in the animal body we found when rats were fed diets containing dried skimmed milk and either peanut oil or soybean oil or corn oil, these dietary oils furnishing about 60 per cent. of the total food calories in each case, the fat or rather oil yielded by the rat in each case was quite similar in iodine number value to that of the food oil. On the other hand, when a diet containing dried skimmed milk and starch (the latter being substituted equicalorically for the oil ingredient of the above diets) was fed, a so-called "hard" fat was obtained. Under all experimental conditions, cod liver oil and yeast were added to the ration as sources of vitamins.

Furthermore, we found it possible to convert the "soft" body fat into a "hard" body fat by changing the oily diet to the carbohydrate-rich diet, provided the change of food took place when the rats were of adolescent age (140–150 gm.) and the feeding of the "hardening" diet was continued over a comparatively long period. For example, the "soft" body fat of 140 gm. rats produced on a soybean oil diet was completely "hardened" on the carbohydrate-rich diet when the latter was fed until rats attained the weight of about 250 gm.

The question naturally arose: What would be the effect of fat depletion through selective starvation on the subsequent rate of "hardening" of the body fat?

In seeking an answer we subjected rats, grown to various weight levels on the oil-containing diets, to a starvation process before feeding the "hardening" diet. We then compared the fat obtained from other

[1] Anderson, W. E., and Mendel, L. B., "A Technique for the Study of Fat Production in Animals," Proc. Soc. Exp. Biol. and Med., 1923–24 (21), 436.

[2] Anderson, W. E., "The Influence of Diet on Fat Production in the Animal Body," Proc. Am. Soc. Biol. Chem., *J. Biol. Chem.*, 1925 (63), XLVI.

rats raised under exactly the same dietary conditions but not subjected to the fat depletion treatment through starvation.

TABLE I

Rats 1456, 1463, 1464, 1448, 1454 and 1462 (all males) raised to 250 gm. (± 3.0 gm.) on D.S.M. (dried skimmed milk) and soybean oil.

Rat

1456 starved from 248 gm. to 184 gm. (25.8 per cent. loss)
1463 starved from 248 gm. to 182 gm. (26.6 per cent. loss)
1464 starved from 247 gm. to 185 gm. (25.1 per cent. loss)

| Rat | | | | Killing weight |
|---|---|---|---|---|
| 1456 | fed D.S.M. and starch | from | 184 gm. to | 275 gm. |
| 1463 | fed D.S.M. and starch | from | 182 gm. to | 280 gm. |
| 1464 | fed D.S.M. and starch | from | 185 gm. to | 272 gm. |

| Rat | | | | Killing weight |
|---|---|---|---|---|
| 1448 | fed D.S.M. and starch | from | 251 gm. to | 280 gm. |
| 1454 | fed D.S.M. and starch | from | 250 gm. to | 288 gm. |
| 1462 | fed D.S.M. and starch | from | 249 gm. to | 268 gm. |

| Rat | Iodine number (Hanus) | D.S.M. and starch diet consumed in days | |
|---|---|---|---|
| | | gm. | |
| 1456 | 71.4 | 453 | 27 |
| 1463 | 76.0 | 533 | 35 |
| 1464 | 71.5 | 435 | 27 |
| 1448 | 115.5 | 442 | 31 |
| 1454 | 108.5 | 355 | 26 |
| 1462 | 109.9 | 406 | 28 |

(123.0 = iodine number of fat produced by rats fed D.S.M. and soybean oil.
60.0 = iodine number of fat produced by rats fed D.S.M. and starch).

In Table I will be found data obtained with six male rats, all of which were raised to a body weight of 250 gm. (± 3.0 gm.) on a diet containing liberal inclusion of soybean oil. During the period of (partial) starvation, to which rats 1456, 1463 and 1464 were subjected, the soybean oil diet was entirely withdrawn, but the vitamin-bearing materials were supplied daily to prevent body depletion thereof.

It will be noted that the fat produced by the starved group of rats is distinctly "harder"—using the iodine number value[3] as a measure of "hardness"—than the fat yielded by the non-starved group. For ready comparison the iodine number values of fat produced by rats fed the soybean oil diet and by other rats fed the diet rich in carbohydrate are added. The amount of the dried skimmed milk and starch diet—"hardening" food—consumed by both the starved and non-starved groups, and the number of days during which it was ingested, are also indicated.

[3] Ellis, N. R., and Isbell, H. S., *J. Biol. Chem.*, 1926 (69), 237, in their "Soft Pork Studies" state "the iodine and refractive index values were an excellent measure of firmness of the adipose tissue."

TABLE II

Rats 1488, 1479, 1487, 1478, 1490 and 1492 (all males) raised to 175 gm. (± 3.0 gm.) on D.S.M. (dried skimmed milk) and peanut oil.

Rat

1488 starved from 172 gm. to 126 gm. (26.7 per cent. loss)
1479 starved from 175 gm. to 128 gm. (26.9 per cent. loss)
1487 starved from 175 gm. to 134 gm. (23.4 per cent. loss)

| Rat | | | | Killing weight |
|---|---|---|---|---|
| 1488 | fed D.S.M. and starch | from | 126 gm. to | 228 gm. |
| 1479 | fed D.S.M. and starch | from | 128 gm. to | 223 gm. |
| 1487 | fed D.S.M. and starch | from | 134 gm. to | 221 gm. |

| Rat | | | | Killing weight |
|---|---|---|---|---|
| 1478 | fed D.S.M. and starch | from | 177 gm. to | 225 gm. |
| 1490 | fed D.S.M. and starch | from | 173 gm. to | 224 gm. |
| 1492 | fed D.S.M. and starch | from | 175 gm. to | 225 gm. |

| Rat | Iodine number (Hanus) | D.S.M. and starch diet consumed in days | |
|---|---|---|---|
| | | gm. | |
| 1488 | 61.9 | 301 | 20 |
| 1479 | 63.5 | 339 | 21 |
| 1487 | 68.0 | 365 | 24 |
| 1478 | 78.3 | 372 | 21 |
| 1490 | 75.0 | 345 | 24 |
| 1492 | 74.3 | 314 | 24 |

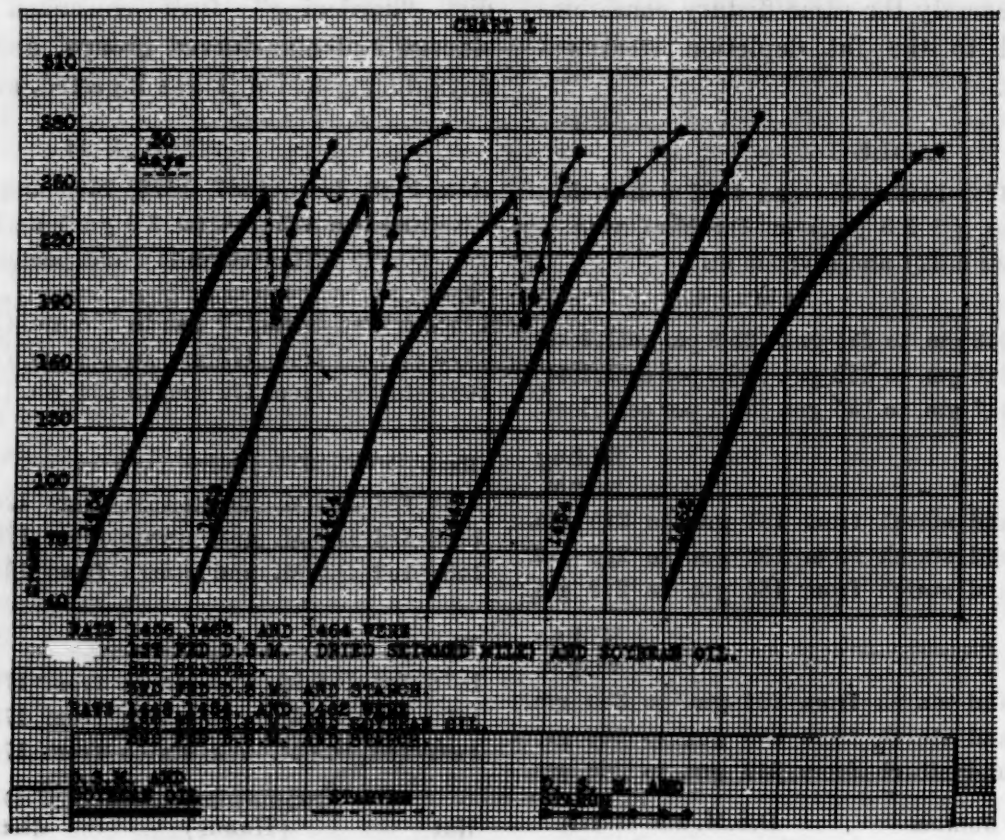
(94.0 = iodine number of fat produced by rats fed D.S.M. and peanut oil.)
60.0 = iodine number of fat produced by rats fed D.S.M. and starch.)

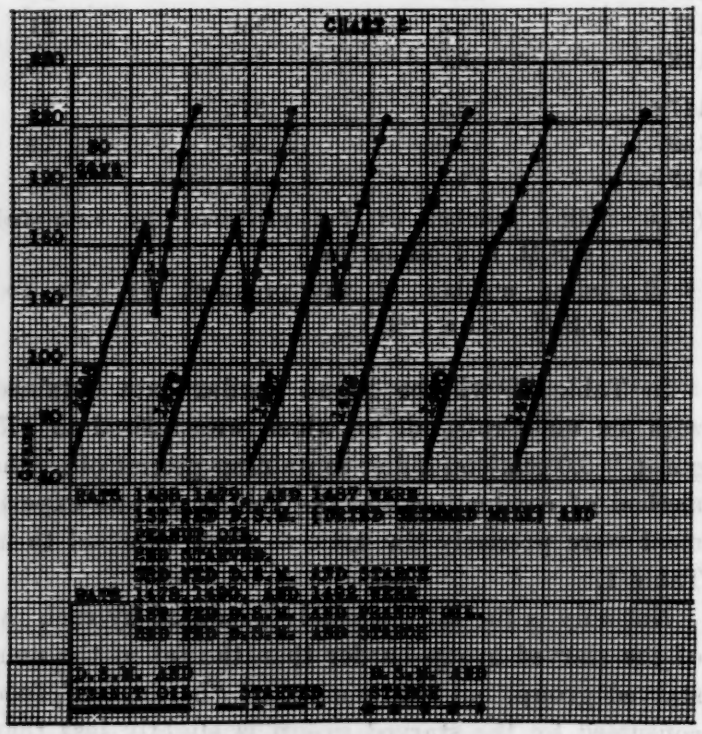
In Table II will be found similar data obtained with six male rats, all of which were raised to 175 gm. (± 3.0 gm.) on a diet containing peanut oil. The method of conducting and the details of this experiment were precisely the same as those referred to in Table I.

Not only is the fat ultimately produced by each rat of the starved group harder than the fat of the non-starved group, but the amount of "hardening" food consumed by the starved group is slightly less than that consumed by the non-starved lot. This is a striking example—and we have noted other similar instances in our present studies—of the food economy, measured in calories, in the starvation-recovery process.

By reference to the accompanying growth curve charts I and II one can readily visualize the very rapid growth experienced during recovery by all animals of both starved groups.

The results referred to are typical of others which we could furnish. We have performed similar ex-





periments in which rats have been raised to various weight levels on diets containing corn oil in addition to those containing soybean and peanut oils.

Experiments are in progress in which rats are being subjected to a longer starvation process, involving over 30 per cent. loss in weight. Upon completion of these studies the results will be published *in extenso*.

## SUMMARY

Rats first fed soybean oil and peanut oil diets, then subjected to the process of fat depletion through selective starvation, involving 23 to 27 per cent. loss in body weight, before being fed a "hardening" diet, yielded "harder" fats—fats of lower iodine number values—than the fats of rats which were not starved before being fed the carbohydrate-rich diet. In other words, through the process of starvation, the "soft" oily fat produced on diets containing soybean[1] or peanut oils is very largely removed, thereby permitting the deposit of a "hard" fat. To obtain a fat of equal "hardness" from rats which were not subjected to the starvation treatment would have required a much longer period of feeding of the diet rich in starch than was found necessary with rats after first being starved.

The growth of recovery made by the rats of the starved lots was made on a low food intake. With the starved rats first fed peanut oil, the food intake of the carbohydrate-rich diet was less than with the non-starved group.

The possible application of these findings to practical animal husbandry is obvious.

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[1] The Proctor and Gamble Company, Ivorydale, Ohio, kindly furnished the soybean oil used in these particular experiments.

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